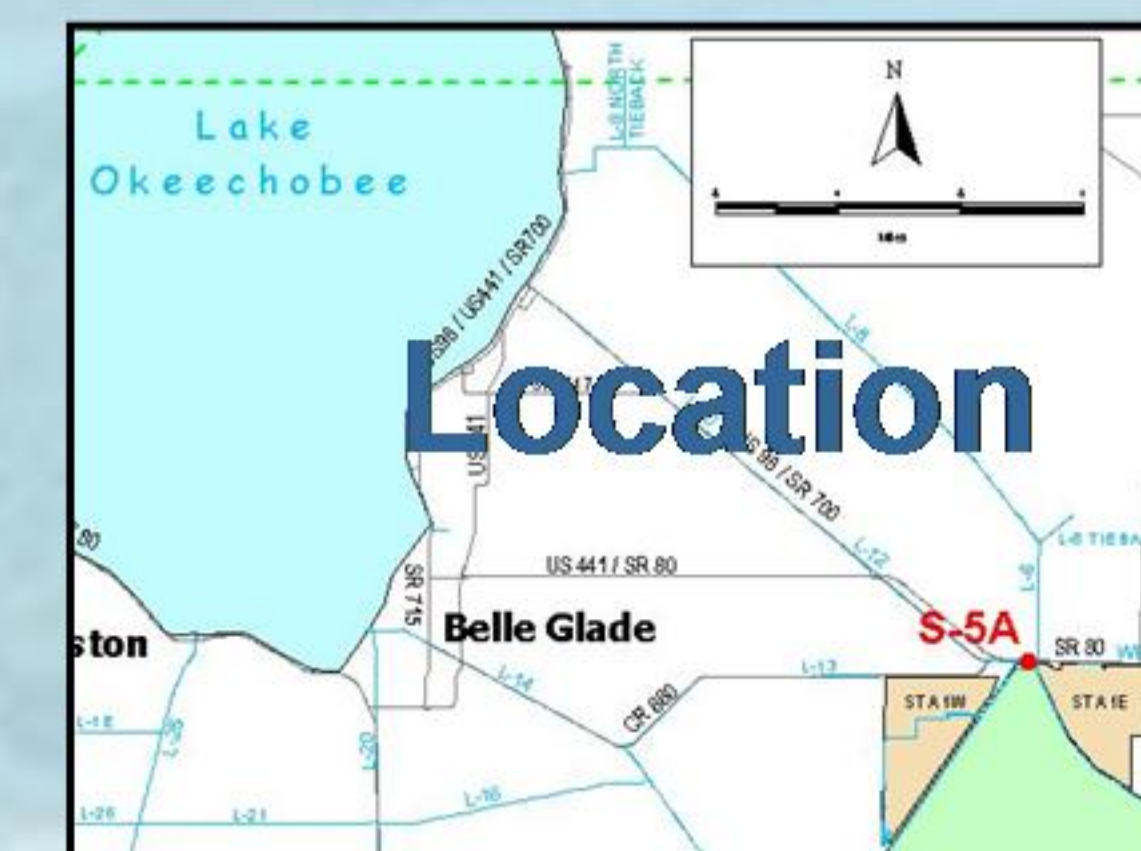




TOTAL-FLOW AUTOMATIC SAMPLER FOR PUMPING STATION S-5A



Importance of S-5A

Entry point for water into the Everglades Protection Area

- Proximity to the Everglades Agricultural Area (EAA) makes it a receiving point for run-off water from sugar and other farms
- Discharge is used for estimating the water quality
 - Runoff is rich in nutrients – especially **phosphorus**
 - Adverse effect of **phosphorus** on the ecology of Everglades
- Everglades Forever Act (EFA)
 - Developing effective EAA-best management practices that focus on improved farm water management techniques and x controlled fertilizer application for reduction in phosphorus levels
 - Quantifying eutrophication (excessive plant growth) for water draining into the Everglades

Sampling Protocol

EAA-EFA Mandates

- require flow-proportional sampling
 - stipulates water quality monitoring system such that total loading of phosphorus can be accurately determined
- Samples must be representative of the overall discharge from the station

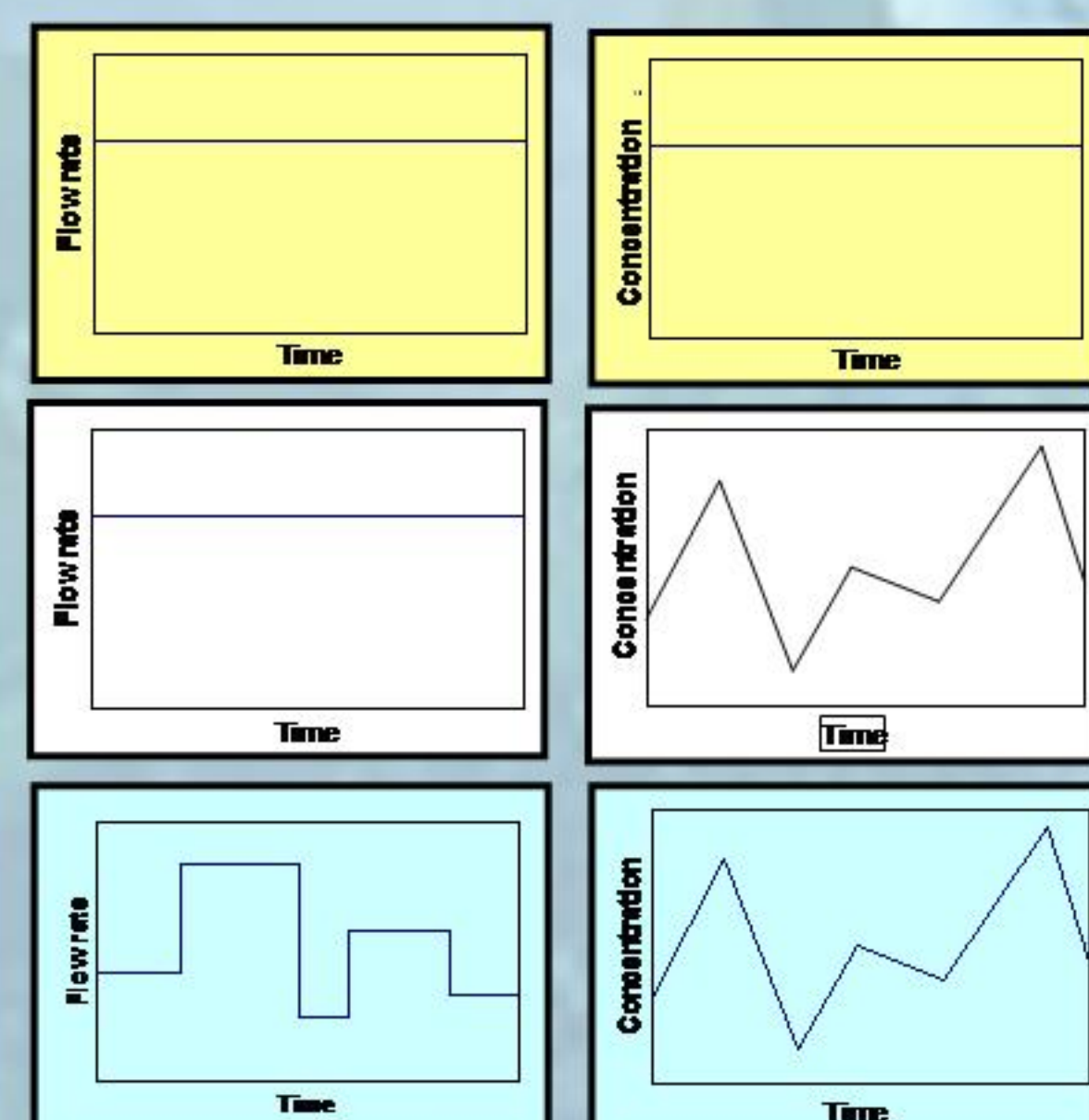


Current Sampling at S-5A

- Auto-sampler 1 that takes samples in conjunction with pump operation from a fixed location
- Totalizer triggers sample collection
 - Frequency – once every 32768 rotations
- Grab samples are also taken, about 15 ft. upstream of the pumping station
 - Frequency – weekly
- Another auto-sampler added upstream during 2001

Limitations of the current auto-sampler

- Location – The sampler is designed to collect the sample aliquot only from the inlet bay at Pump 4
- If pump(s) other than Pump 4 are running, sampling is from a stagnant zone
- Variations in phosphorus concentration with time – might not be adequately captured in the ...aliquots i.e. the samples collected are not representative of flow
- Total Phosphorus Loading based on such a **sample** is not accurate



Sampling & Load Determination

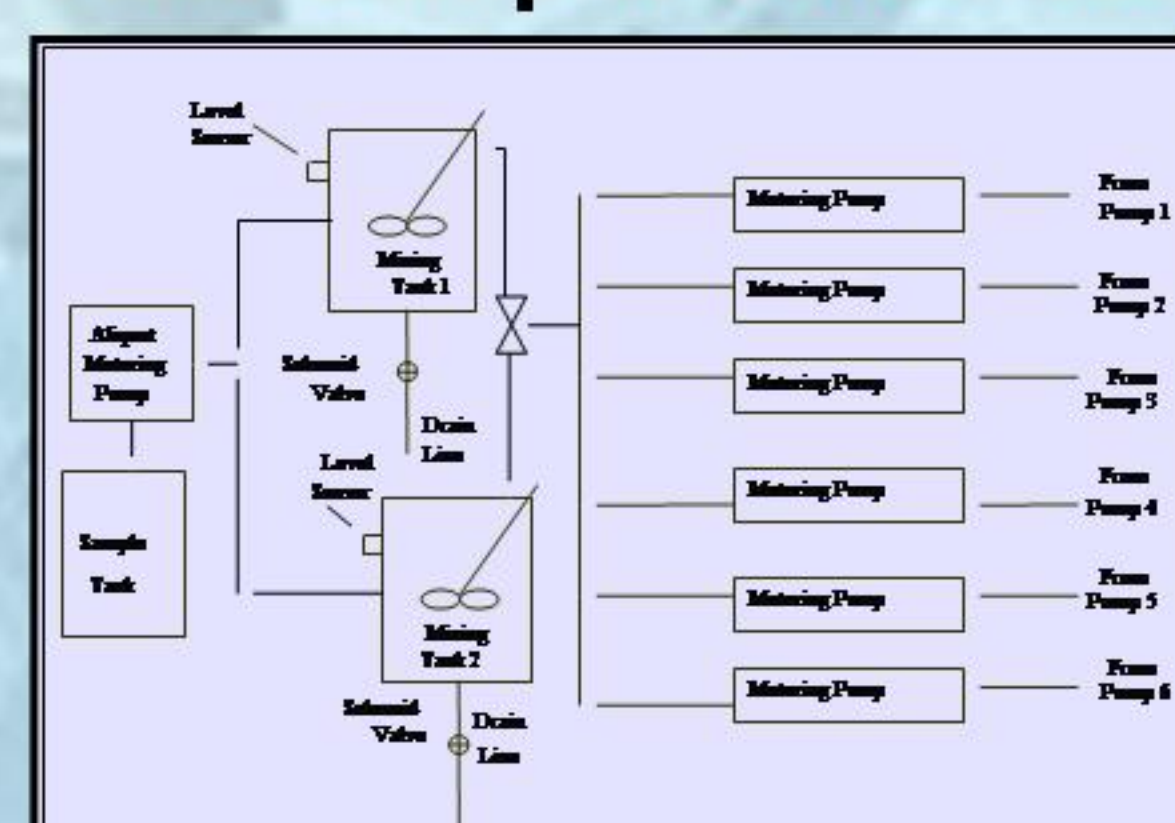
Sampling Situations

- Constant flow and constant concentration
- Constant flow but varying concentration
- Varying flow and varying concentration-
...flow proportional

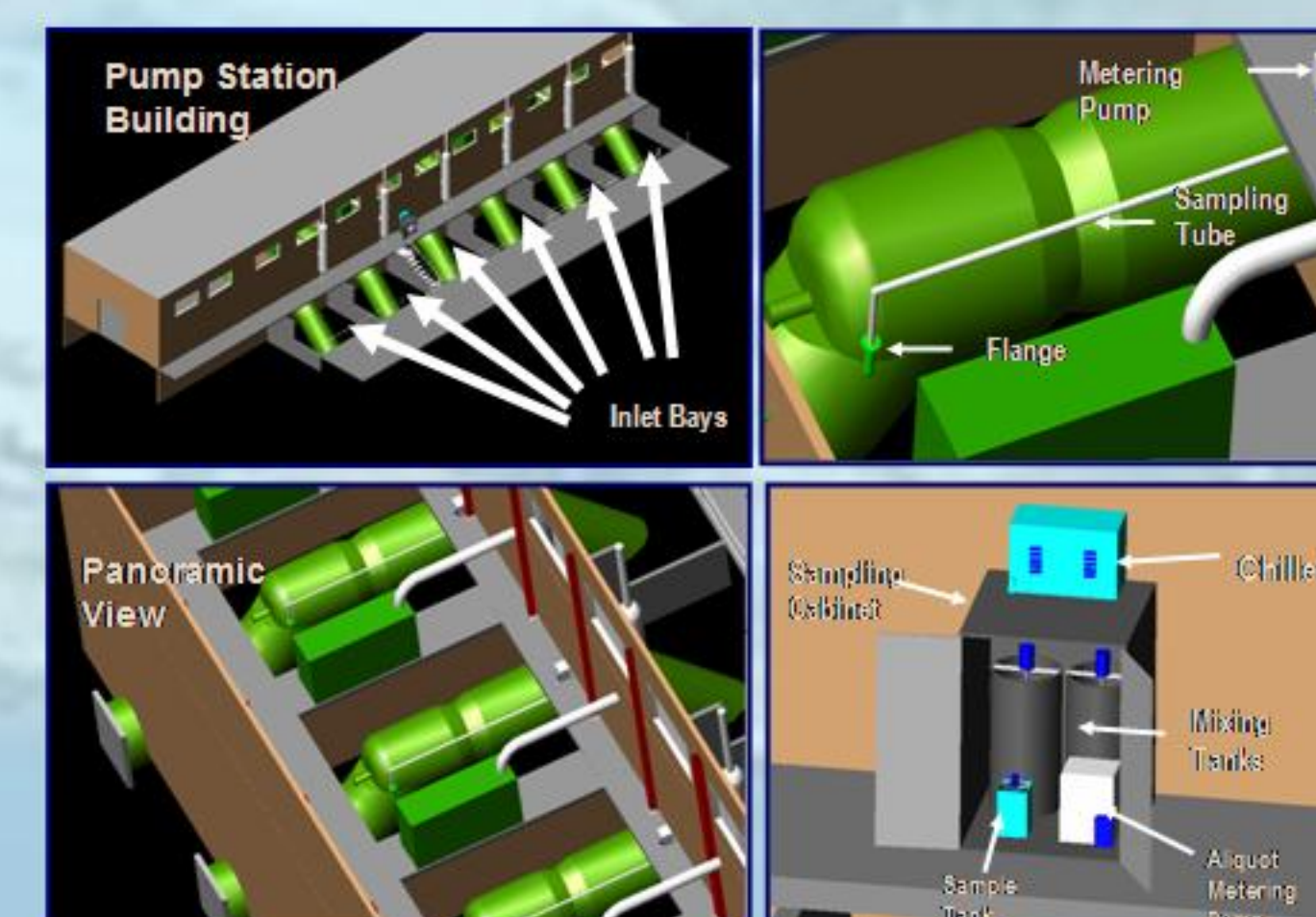
Background

- S-5A pumping station in the Palm Beach County located at the northern tip of the Water Conservation Area 1 (WCA1)
- Consists of six axial flow pumps 116 in. dia and rated at 800 cfs
- Pumps surplus water from agricultural area, L-10, L-12 basin into Water Conservation Area 1 (WCA1)

Proposed Total Flow Auto-Sampler Schematic

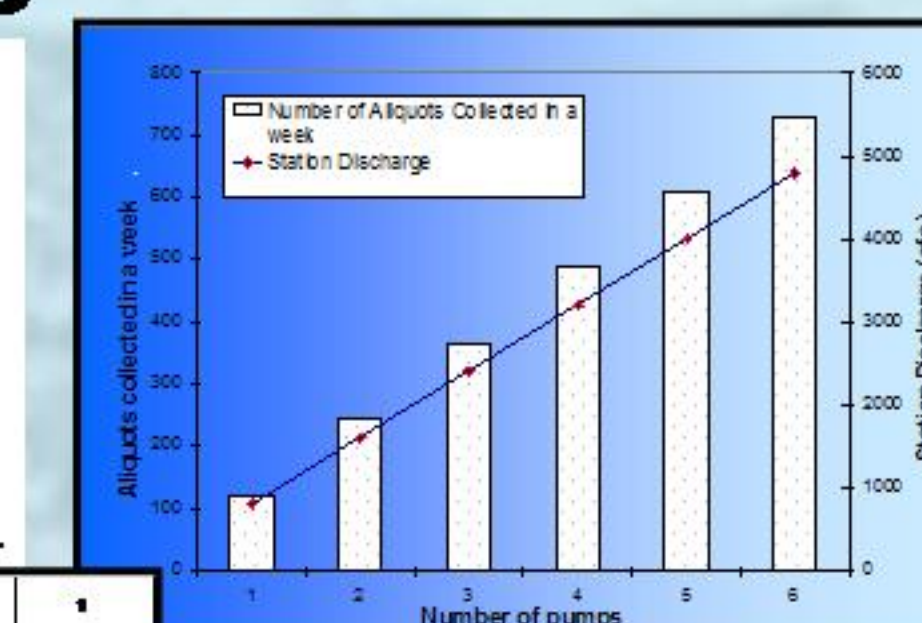


System Conceptualization



System Design

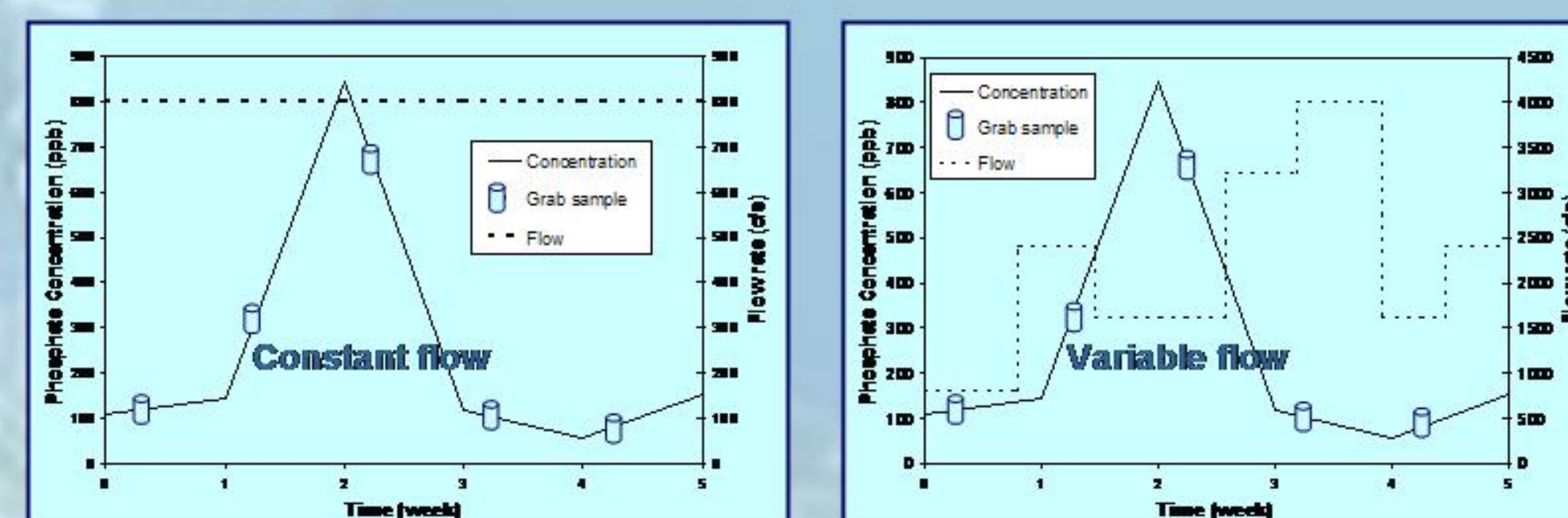
- Flowrate in sampling tube – 6 ft/s (max)
- Diameter of sampling tube – 3/8 in.
- Length of sampling tube – 120 ft (max)
- Volume of Mixing tank(s) – 55 gal (208 L)
- Volume of Sample Tank – 10 gal (38 L)
- Volume of each aliquot sample – 50 mL
- Frequency of Aliquot Sampling – Once every 5 minutes (at maximum discharge).



Number of Pumps	1	2	3	4	5	6
Flow rate (cfs)	4000 (1.16)	4000 (1.16)	3700 (1.04)	3600 (1.00)	1800 (0.51)	800 (0.23)
Flow rate (m³/s)	13	13	13	13	6	3
Flow rate (m³/min)	4.6	4.6	4.6	4.6	2.3	1.2
Flow rate (m³/hr)	4.6	4.6	4.6	4.6	2.3	1.2
Flow rate (m³/day)	230	230	230	230	115	58
Flow rate (m³/week)	1610	1610	1610	1610	805	406
Flow rate (m³/month)	6840	6840	6840	6840	3420	1704
Flow rate (m³/year)	82080	82080	82080	82080	41040	20448

* A flow rate of 2 gpm for the metering pump corresponds to a discharge rate of 800 cfs through the main pump

Error Estimation



- Error associated with the sampling technique – assuming that there are no measurement or instrument errors
- Variations in concentration with time
- For two cases of discharge:
 - constant discharge
 - varying discharge

Aliquots collected	Case 1	Case 2
S-5A Grab	5	5
S-5A Auto-sampler	1120	3090
Proposed Total flow Auto-sampler	1832	4784

	CASE1	CASE2
True	1762	481
SEA Grab	175	09
SEA Auto-sampler	1761	006
Proposed Total flow auto-sampler	1762	0

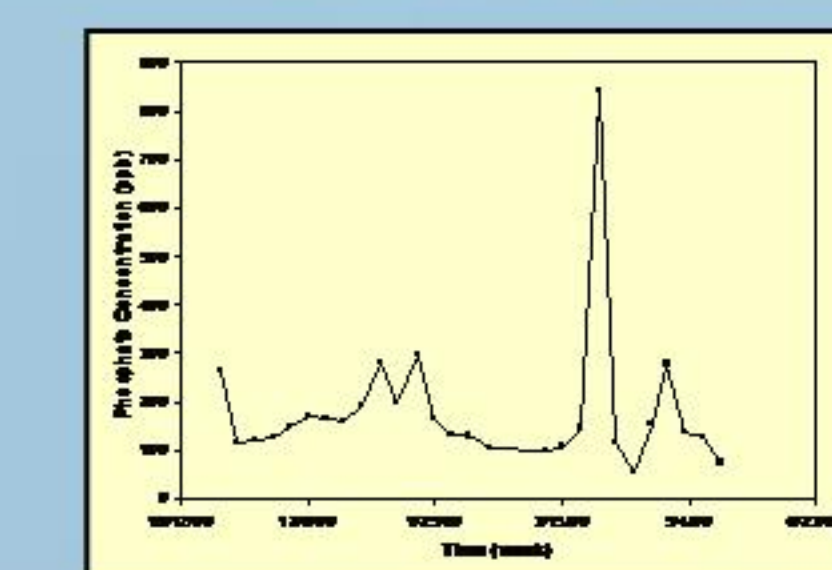
Assumption:
Current auto-sampler collects samples that are representative of the discharge

Bench-scale Study

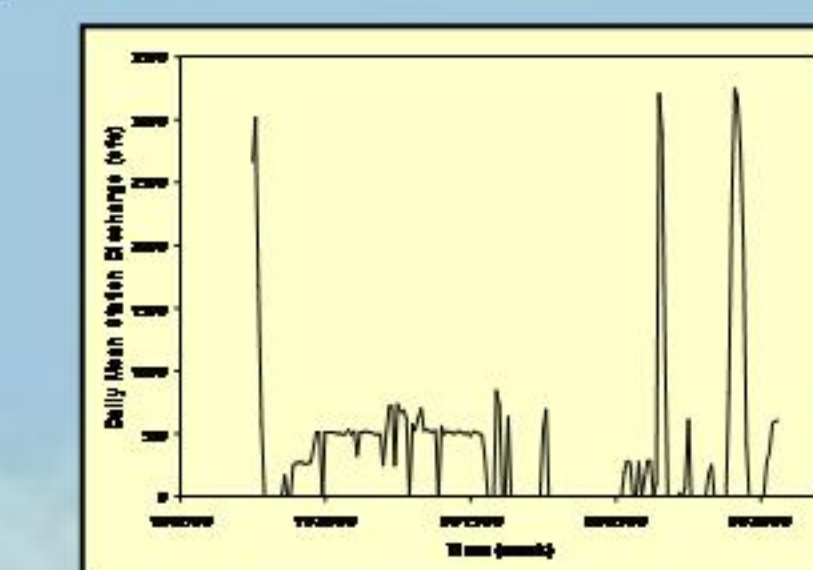


Concept demonstrated using a bench-scale system

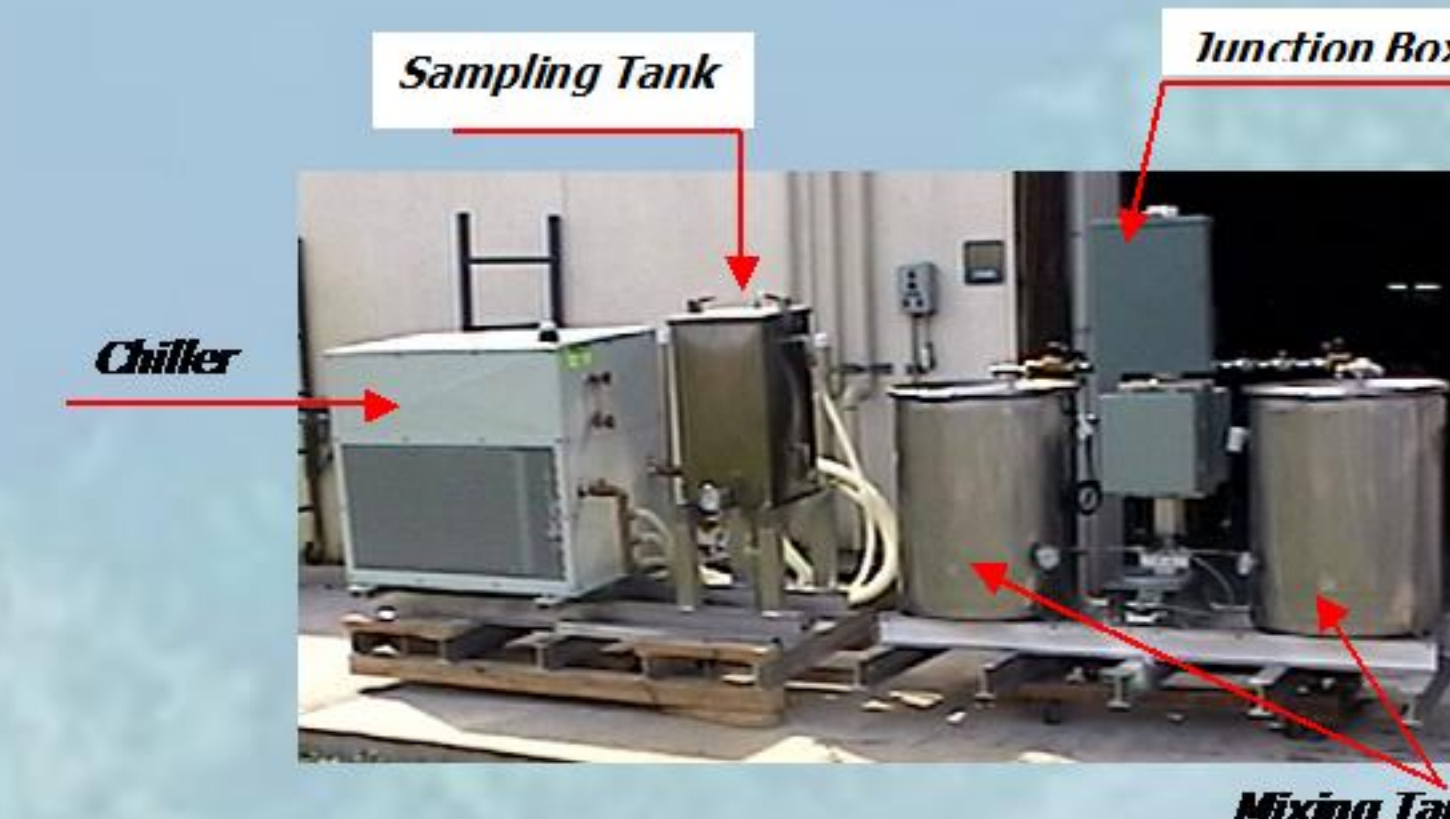
Error Analysis Results



Phosphorus concentration based on actual grab samples taken at S-5A, from November 1999 to May 2000 (26 weeks)



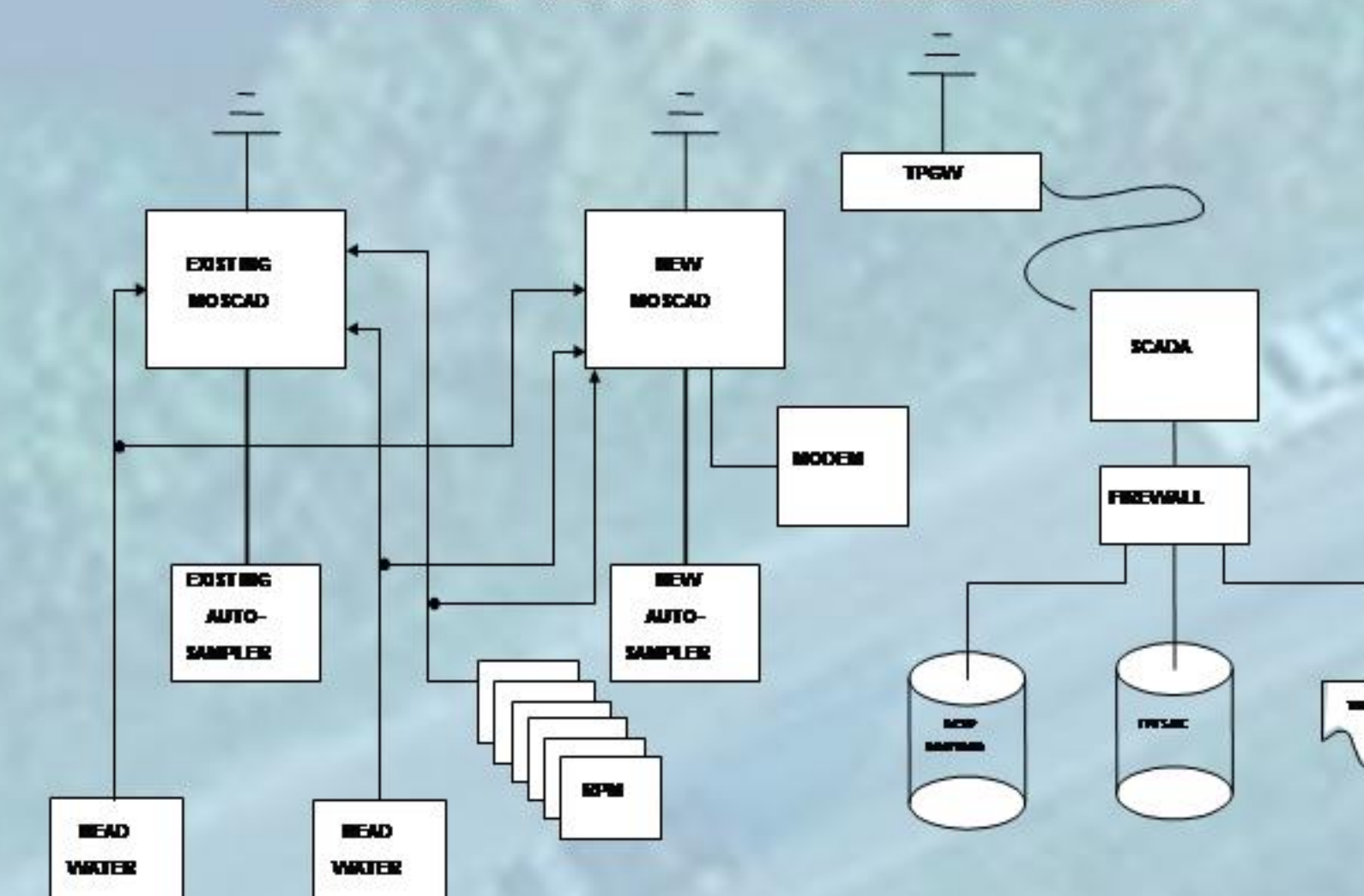
Actual discharge from the S-5A, from November 1999 to May 2000 (26 weeks) obtained from DCF/EDRD



Source	Relative Error present	Relative Error caused (in determining phosphorus loading)
Flow computation	± 10%	± 0.5 %
Sampling stream flow (metering pump)	± 2%	± 0.05%
Aliquot metering	± 0.5%	± 0.005
All three combined		± 1%

New Autosampler – Installed MOSCAD System – Communication Protocol

INTERFACE OF NEW MOSCAD AND EXISTING SYSTEM



Proposed Total Flow Auto-Sampler - Summary

- Total flow sampler samples continuously at a rate proportional to the discharge flow
- Capable of sampling from all the pumps, thereby ensuring representative sampling
- Valves and metering pumps easily available (off the shelf) and replaceable
- Completely refrigerated system
- Robust control, data logging and remote query using MOSCAD

Basis of the Proposed Total Flow Auto-sampler

- Representative sampling
 - Sample from each operational individual pump
- Flow-proportional
- Continuous sampling of the discharge

Total Flow Continuous Auto-Sampler

